TIERA TRAINING MANUAL

Welcome to the TIERA Training Institute

Thank you for your interest in TIERA's training courses! We are delighted to provide a comprehensive range of certified training courses in various fields. This document serves as your registration guide for TIERA's Training Course, offering valuable details on course topics, schedules, examination procedures, venue locations, and study options (public, onsite, or online).Should you have any inquiries during the process, our dedicated Training team is readily available to assist you. To receive a personalized quotation, kindly complete the Website form or return the PDF. We trust that all the information you need can be found within these pages.

Why Choose TIERA?

Experience a groundbreaking way to excel in vibration analysis training with TIERA! We recognize that four days of training as per ISO18436-2 may not suffice to master this crucial skill, so we offer an extensive 12 months course, setting us apart from the other expensive but traditional four-day programs. When you enroll in a Public course, you gain exclusive access to the industry-standard TOLearnVibe training system (student version) through our cutting-edge student online 'Learning Portal.' Our esteemed instructors and top-notch training aids ensure an immersive learning experience that equips you for real-world challenges.

But our commitment to your success doesn't end there. Once you're back at work, you can continue learning with TOLearnVibe (student edition) because we understand that the toughest questions arise under pressure, not during the course. With TIERA, you can now take the instructor home with you, enabling continuous education beyond the classroom.Preparation is key to success, and our Pre-study option offers TOLearnVibe Student Edition. By exploring lessons via your Web browser before the course, you'll gain even more from the training, maximizing your knowledge retention.

Experience a transformational training environment at TIERA, where we redefine learning with cutting-edge simulators and captivating 3D animations. Complex concepts become crystal clear in no time, thanks to our state-of-the-art technology. Engage in immersive classroom activities and interactive discussions with our expert instructors, ensuring a deep understanding and lasting retention of the material. With TIERA's world-class Machinery Fault Signature Simulators (TMFSS) and TVIB vibration analysis software equipped with PhonoVibe analyzers, industry-level expertise is now accessible to beginners and experts alike. Elevate your skills and knowledge with an unmatched

The learning journey never ends at TIERA. We believe in ongoing education and offer access to the online 'learning zone' for either 4 months or a Life-Long Learning subscription. Our extensive training materials, such as iLearn Reliability CM and iLearn Reliability (Professional), enrich your knowledge further.

Our promise is to provide you with the very best. We value your commitment to training, and we match it with our dedication to optimize your classroom experience. Expect excellent slides, animations, simulators, interactive activities, and challenges led by experienced instructors. When you leave our training, you'll take home a comprehensive reference manual, a diagnostic reference guide, and the acclaimed TOLearnVibe computer-based training system for 12 months subscription (Total duration from time of purchase).

At TIERA, your time spent in the classroom is a valuable investment, empowering you to continue learning and growing after you return to your place of work. Choose TIERA, where education is an enriching journey that paves the way to professional success and personal growth

Vibration Analyst category 1 guidelines (TCAT I)

Category I Vibration Analysts are qualified to perform a range of single channel machinery vibration condition monitoring and diagnostic activities including data acquisition on predetermined routes, machine steady state testing to predefined procedures, and comparison of readings against pre-established alert

- Minimum Required Experience: 6 months
- Minimum Training Hours: 30 hours
- Recommended Vibration Training meeting requirement: TCAT I Online course + internship (optional)

Category I Body of Knowledge/Training Course Topics:

Vibration Principles (6Hrs)

- Basic motion
- Period, Frequency
- Amplitude (Peak, Peak-to-Peak, RMS)
- Measurements (Displacement, Velocity, Acceleration)
- Time Orbital and Frequency Domains
- Phase Natural Frequency, Resonance, Critical Speeds
- Shaft and Casing Vibration

Data Acquisition (6 Hrs)

- Instrumentation (and acquire readings)
- Transducers
- Sensor Mounting, Mounted Natural Frequency
- Test Procedures
- Computer Database Upload/Download
- Recognition of Poor Data
- Vibration System Calibration

Condition Monitoring (4 Hrs)

- Vibration Severity
- Recognition of Baseline Variations

Signal Processing (6 Hrs)

- FFT Application

Data Acquisition (4 Hrs)

- Basic Spectrum Analysis
- Spectral Harmonics and Sidebands.

Acceptance Testing (2 Hrs)

- Test Procedures

Equipment Testing and Diagnostics (2Hrs)

- Process Safety

Fault Severity Determination (4Hrs)

- Levels (Overall, Narrowband, Component)

Field Balancing (2 Hrs)

- Single-plane

The Process and norms:

- Meet the work experience requirement of 6 Months (Verifiable)
- Meet the minimum vibration training requirement of 30Hrs
- Register for the TCAT 1 training course @ https://learn.tieraonline.in/courses/
- Register for the exam after completing the training and submitting the course completion certificate to info@tieraonline.in
- Complete your certification application by uploading the experience details and immediate mentor for verifying the same via email.
- Register for exams after only getting confirmation from info@tieraonline.in
- Format: Online learning/audit/certification
- The course site includes workbooks that candidates must complete after studying each section through graded quizzes for internal marks. Additionally, PDF study guides and downloadable formula sheets and notes are available on the site. Registered students are given access to the online version of the course via the TIERA's online learning portal for six months.
- **Compliance:** ISO 18436 Category I – Vibration Analyst, ASNT SNTTC-1A Recommended Practice.
- **Educational requirements:** There is no formal education requirement for sitting for any certification exam per ISO 18436-2, however, candidates. are expected to be able to manipulate simple algebraic equations, use a basic scientific calculator, and be computer literate. It is recommended that candidates for Category I and Category II have at least a 10,+2 education in India or high school abroad. Diploma/BTech is preferable but not mandatory.
- **Certification examination:** The certification examination is a proctored online test lasting 2 hours **(with 65+ questions)**, with a passing grade requirement of 75% (online requirement, 70% for offline exam). It follows ISO 18436-3 guidelines and is a closed book exam. Formula sheets are allowed as instructed. Exams will be practical in nature consisting of MCQ and short answer questions. An invigilator will monitor the exam via webcam to ensure proper conduct, and candidates must keep their webcams on throughout the exam, with the session recorded for future verification. Students can use their own scientific calculator or a basic non-programmable calculator available at the exam site, but smartphones and internet browsing are strictly prohibited during the examination.
- **Cheating and forgery:** Those found cheating, colluding, forging certificates, or violating the Code of Ethics will face immediate exam disqualification, certification revocation, and a minimum 48-month reapplication waiting period.
- **Results:** Upon completion, TIERA will provide a score and a written summary of the results based on the categories to candidate registered email within 21 business days.
- **Re-Examination:** A candidate who fail to attain the passing grade in the examination can wait a minimum of 30 days before re-examination. Separate registration and fee are applicable for every retest.
- **Additional training:** As per ISO 18436-2 guidelines, allows candidates to attend optional on-job training or internships in the vibration analysis-related field. The training should have a minimum duration of 15 hours (half the category training requirement) and can be part of academic programs, research, or job experiences. TIERA highly recommends and offers free internship for students/researchers/technicians in the field of vibration analysis.
- **Online credential Management:** TIERA maintains its list of certified vibration analysts in its private portal https://certificates.tieraonline.in/. One can verify the credentials by entering email or certificate number.
- **Recertification:** CAT 1 certification is valid for 5 years, after which it expires. To recertify, individuals must pay the recertification fee. However, those applying for TIERA's higher category exams are exempt from recertification.
- **Certification Prerequisite:** Prior experience is not required for attending the training course, but 6 months of experience is required for certification.
- **Outcome:** You will come away from this course with a very good understanding of vibration analysis fundamentals, you will understand how to take good measurements, and you will be ready to begin analyzing vibration spectra.

Visit our website and preview the TCAT 1 courseware, certification exam sample, certificate sample, credential management system sample, guidelines etc.

TCAT I Sample questions

1. What are the units of vibration displacement?
    a. meters
    b. inches/mm
    c. centimeters
    d. feet

2. The period of vibration is typically measured in
    a. seconds
    b. milliseconds
    c. minutes
    d. hours

3. A vibration transducer used to evaluate pump faults and condition should be mounted
    a. on the floor.
    b. on the piping.
    c. close to the machine bearings.
    d. on the ceiling.

4. In vibration testing, the Fast Fourier Transform is used to
    a. obtain the amount of vibration at machine frequencies.
    b. transform machine vibration into heat.
    c. generate a vibration waveform.
    d. analyze machine temperature.

5. Baseline vibration measurements are made to
    a. evaluate the life of equipment.
    b. generate new design information.
    c. provide a basis for future comparisons of data.
    d. monitor power consumption.

6. A gearbox can be used in a machine train to
   a. increase speed.
   b. lower speed.
   c. both a & b.
   d. decrease heat losses.

7. A 60 Hz two-pole induction motor operates
   a. at slightly less than 3,600 RPM under load.
   b. at 1600RPM.
   c. with no slip.
   d. at 7,200 RPM.

8. The principal function of acceptance testing is to obtain
   a. equipment that meets a specification.
   b. baseline data.
   c. a fault analysis.
   d. a maintenance plan.

9. The vibration level at running speed on a fan increased from 0. 1 inch per second to 0.2 inch per second over the period of 3 months. What is the possible cause of the increase in vibration?
   a. loss of a blade material due to wear or dirt accumulation
   b. small rolling element bearing defect
   c. change in the weather
   d. change in operational conditions

10. Operation of a machine at its critical speed
   a. may cause decreased vibration levels.
   b. may not change the vibration levels.
   c. may increase vibration levels.
   d. will increase its efficiency.

11. What unit is used to measure ISO 10816 based limits?
   a. decibels
   b. hertz
   c. watts
   d. mm/s (inch/s)

12. The natural frequency of a vibrating system depends on its
   a. mass
   b. Force
   c. amplitude
   d. power

13. A common method to detect imbalance in rotating machinery is by using
   a. ultrasonic testing
   b. thermography
   c. vibration analysis
   d. radiography

14. Which type of bearing is known for its ability to support both radial and axial loads?
   a. roller bearing
   b. thrust bearing
   c. ball bearing
   d. sleeve bearing

15. Vibration analysis is an essential and popular tool for monitoring the condition of
   a. electrical circuits
   b. heating systems
   c. rotating machinery
   d. medical condition

16. Fill in the blanks:

I. Vibration velocity is typically measured in _____.
II. FFT stands for _____.

17. Short answer (1 line):
I. What is the principal function of acceptance testing?
_____.

Answers:

1. b (inches/mm)
2. a (seconds)
3. c (close to the machine bearings)
4. a (obtain the amount of vibration at machine frequencies)
5. c (provide a basis for future comparisons of data)
6. c (both a & b.)
7. a (at slightly less than 3,600 RPM under load.)
8. a (equipment that meets a specification)
9. a (loss of a blade material due to wear or dirt accumulation)
10. c (may increase vibration levels)
11. d (mm/s (inch/s))
12. a (mass)
13. c (vibration analysis)
14. a (roller bearing)
15. c (rotating machinery)
16. Fill in the blanks:
   I. inches per second or mm/s or velocity units
   II. Fast Fourier Transform
17. Short answer (1 line):
   I. To test and assure that equipment meets desired specification without defects.

Vibration Analyst category II guidelines (TCAT II)

Category I Vibration Analysts are qualified to perform a range of single channel machinery vibration condition monitoring and diagnostic activities including data acquisition on predetermined routes, machine steady state testing to predefined procedures, and comparison of readings against pre- established alert settings.

Why Choose TIERA?

- Minimum Required Experience: 18 months or 12 months under two options.
  - Option 1: Minimum Required verifiable Experience in vibration related field: 36months
  - Option 2: Minimum Experience/Education Combo: 12 months + 2-Year Tech Degreeor 4-Year College Degree
- Minimum Training Hours: 38 hours
- Recommended Vibration Training meeting requirement: TCAT II Online course + internship (optional)

Category II Body of Knowledge/Training Course Topics:

Vibration Principles

- Basic motion
- Period, Frequency
- Amplitude (Peak, Peak-to-Peak, RMS)
- Measurements (Displacement, Velocity, Acceleration)
- Time Orbital and Frequency Domains
- Phase Natural Frequency, Resonance, Critical Speeds
- Shaft and Casing Vibration

Data Acquisition

- Instrumentation (and acquire readings)
- Transducers
- Sensor Mounting, Mounted Natural Frequency
- Test Procedures
- Computer Database Upload/Download
- Recognition of Poor Data
- Vibration System Calibration

Fault Analysis

- Basic Spectrum Analysis
- Spectral Harmonics and sidebands
- Time WaveformAnalysis
- Phase Analysis
- Transient Analysis
- Orbital Analysis
- Shaft Centre-line Analysis
- Enveloping
- Mass Unbalance
- Misalignment
- Concentricity Errors Mechanical Looseness
- Rubs Instabilities
- Shaft Bow
- Bearing (Rolling Element, Journal) Defects
- Electric Motor Defects
- Gearbox Defects
- Resonance and Critical Speeds

Signal Processing

- Analogue and Digital; Sampling
- FFT Application
- Windows (Uniform, Hanning, Flat-top)
- Understanding signals: modulation, beating, sum/difference
- Filters (Low pass, High Pass, Band Pass, Tracking)
- Anti-aliasing
- Band-width, Resolution
- Noise Reduction
- Averaging (Linear, peak hold, Synchronous Time, Exponential)
- Dynamic Range
- Run-out Compensation

Corrective Action Recognition (2 Hr)

- Shaft Alignment
- Concentricity
- Balancing
- Basic Maintenance
- Action
- Lubrication

Acceptance Testing

- Test Procedures
- Specifications and Relevant Standards
- Acceptance Test Reporting

Reference Standards

- Relevant International (ISO, IEC), National and Regional Standards

Field Balancing

- Single-plane Field Balancing:Two-plane

Equipment Testing and Diagnostics

- Impact Testing
- Forced Response Testing (e.g.Coherence, Transfer Function)
- Modal Analysis
- Process Safety

Reporting and Documentation

- Vibration CM Reports
- Machine History Records
- Decision Making and Recommend Action

Fault Severity Determination

- Levels (Overall, Narrowband,Component)
- Spectrum Analysis
- Time Waveform and Orbit Analysis
- Severity Charts, Graphs, Formulae

Theoretical Rotor and Bearing Dynamics (1 Hrs)

- Rotor Characteristics
- Bearing Characteristics

The Process and norms:

- Meet the work experience requirement of 18 Months (Verifiable) or options
- Meet the minimum vibration training requirement of 38Hrs
- Register for the TCAT II training course @ https://learn.tieraonline.in/courses/
- Register for the exam after completing the training and submitting the course completion certificate to info@tieraonline.in
- Complete your certification application by uploading the experience details and immediate mentor for verifying the same via email
- Register for exams after only getting confirmation from info@tieraonline.in
- Format: Online learning/audit/certification
- The course site includes workbooks that candidates must complete after studying each section through graded quizzes for internal marks. Additionally, PDF study guides and downloadable formula sheets and notes are available on the site. Registered students are given access to the online version of the course via the TIERA's online learning portal for six months.
- Compliance: ISO 18436 Category II – Vibration Analyst, ASNT SNTTC-1A Recommended Practice

- Educational requirements: There is no formal education requirement for sitting for any certification exam per ISO 18436-2, however, candidates are expected to be able to manipulate simple algebraic equations, use a basic scientific calculator, and be computer literate. It is recommended that candidates for Category I and Category II have at least a 10+2 education in India or high school abroad. Diploma/BTech is preferable but not mandatory
- **Certification examination:** The certification examination is a proctored online testlasting 3 hours (105+ questions), with a passing grade requirement of 75% (70% for offline test). It follows ISO 18436-3 guidelines and is a closed book exam. Formula sheets are allowed as instructed. Exams will be practical in nature consisting of MCQ and short answer questions. An invigilator will monitor the exam via webcam to ensure proper
- **Cheating and forgery:** Those found cheating, colluding, forging certificates, or violatingthe Code of Ethics will face immediate exam disqualification, certification revocation,and a minimum 48-month reapplication waiting period
- **Results:** Upon completion, TIERA will provide a score and a written summary of theresults based on the categories to candidate registered email within 21 business days.
- **Re-Examination:** A candidate who fail to attain the passing grade in the examination canwait a minimum of 30 days before re-examination. Separate registration and fee areapplicable for every retest
- **Additional training:** As per ISO 18436-2 guidelines, allows candidates to attend optional on-job training or internships in the vibration analysis-related field. The training should have a minimum duration of 19 hours (half the category training requirement) and can be part of academic programs, research, or job experiences. TIERA highly recommends and offers free internship for students/researchers/technicians in the field of vibrationanalysis
- **Online credential Management:** TIERA maintains its list of certified vibration analysts in its private portal https://certificates.tieraonline.in/. One can verify the credentials by entering email or certificate number
- Recertification: CAT 2 certification is valid for 5 years, after which it expires. To recertify, individuals must pay the recertification fee. However, those applying for TIERA's higher category exams are exempt from recertification
- **Certification Prerequisite:** Prior experience is not required for attending the training course, but 18 months of experience (or options) is required for certification
- Outcome: You will come away from this course with a very good understanding of vibration analysis fundamentals, you will understand how to take good measurements, and you will be ready to begin analyzing vibration spectra
    - Identify measurement activities for routine data collection.
    - Understand and apply basic principles of signal analysis for data acquisition and analysis settings
    - Perform basic single-channel impact tests to determine natural frequencies
    - Interpret and evaluate test results in line with specifications and standards
    - Diagnose common faults and recommend basic corrective actions based on machinery experience.
    - Provide technical guidance and instruction to category I personnel

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TCAT II Sample questions

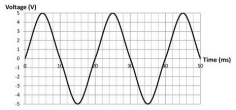
CATEGORY II SAMPLE QUESTIONS

1. A nonrepeatable motion is best described as
    a) Pulsating
    b) Impacting
    c) Random
    d)Harmonic

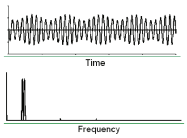
2. What measure has been shown to be most effective for evaluation of general machine condition from bearing cap measurements?
    a. displacement
    b. acceleration
    c. mils
    d. velocity

3. What is the most basic display that can be used to directly determine the phase relationship between the vibrations measured at two locations on a machine?
    a. amplitude vs. frequency
    b. polar plot
    c. Bodé plot
    d. time waveform

4. What is the frequency of the waveform shown in Figure?
a. 100Hz
b. 50 Hz
c. 75Hz
d. 200Hz



5. The data shown in Figure shows which possible condition.
    a. beating
    b. misalignment
    c. inner bearing fault
    d. rotor bar fault



6. The frequency span used for fault analysis on an FFT analyzer is Concerned with
    a. dynamic range.
    b. phase distortion.
    c. resolution.
    d. amplitude.

7. Vibration from rotor mass unbalance appears in the spectrum at a frequency of
    a. three times operating speed.
    b. four- and one-half times operating speed.
    c. one times operating speed.
    d. one half times operating speed.

8. Calculate the gear-mesh frequency for a gear set with 28 pinion teeth and 99 gear teeth. The
pinion operates at 1,776 RPM.
a. 500 Hz
b. 30,000 CPM
c. 49,728 CPM

9. An accelerometer was used to measure 2 g's peak at 565 Hz. What was the peak vibration velocity?

a. 0.2 mil
b. 2 mils
c. 0.02 inch/second
d. 0.22 inch/second

10. The first alarm or alert is set on a data collector to initiate

a. a fault analysis.
b. a time-to-failure calculation.
c. a reduction in the alarm setting.
d. machine shutdown.

ANSWERS TO SAMPLE QUESTIONS FOR CATEGORY II:
1. c, 2. d, 3. d, 4 b, 5. a, 6. c, 7. c, 8. c, 9. d, 10. a